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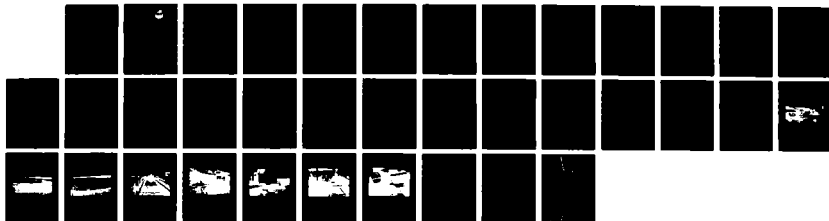
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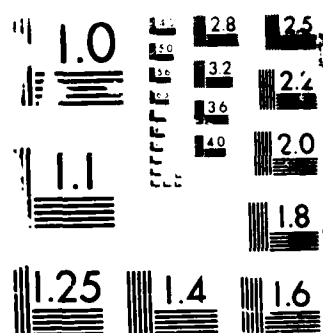
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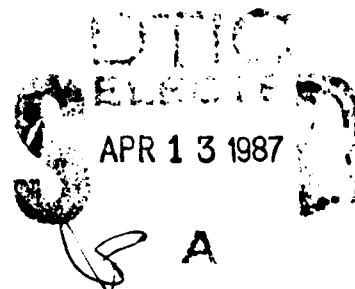
**SPACE LAUNCH COMPLEX 6 WASTEWATER TREATMENT
FACILITIES EVALUATION, VANDENBERG AFB CA**

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February 1987

Final Report



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**USAF Occupational and Environmental Health Laboratory
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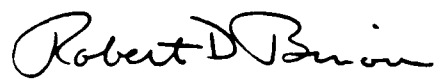
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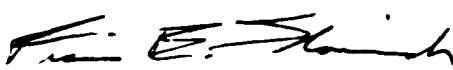


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19 ABSTRACT (Continue on reverse if necessary and identify by block number) The USAFOEHL conducted a survey evaluating the wastewater treatment facility at the Space Launch Complex 6 (SLC-6), Vandenberg AFB, California. The scope of the survey included the evaluation of: (1) Plant influent and effluent quality, (2) Plant flows, (3) Lift station sewage quality, (4) Percolation pond water quality, (5) Percolation pond discharge flow rate. Results of the survey showed that the treatment plant was not meeting the State of California "zero discharge" limitation because of hydraulic overloading. Hydraulic overloading was the probable cause of high suspended solids in the plant effluent. The percolation ponds ability to dispose of the wastewater suffered from this heavy solids loading. The long residence time in the lift station, and the surge of flow to the plant caused by Lift Station 1 adversely affected the treatment process. (over) <i>(Key word...)</i>				
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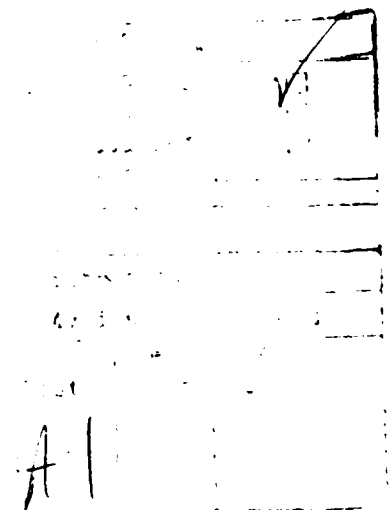
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Recommendations: (1) Install a flow measuring device at the plant. (2) Adjust the volume pumped from Lift Stations 1 and 2. (3) Increase testing requirements. (4) Clean the percolation ponds. (5) Install monitoring wells around the percolation ponds. If Launch operations resume and the expectant total working population exceeds 550, enlarge the aeration basin and clarifier capacity, and consider the construction of another percolation pond or deep well injection system.

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The authors greatly appreciate the technical expertise and hard work provided by the other members of our survey team, 1Lt Mary M. Daly, who helped prepare much of this report, MSgt "Bubba" Burbage, Sgt Tammy Johnson, A1C Roberto Rolon and A1C Pete Davis without whose valuable assistance this survey could never have been accomplished.

We also acknowledge the help Major Jerry Morford, CMSgt Emmerich, and Mr Brad Hagemann provided in solving the big and little problems that seem to always crop up during surveys of this nature.



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I. INTRODUCTION

On 24 Mar 86, HQ SAC/SGPB requested the USAF Occupational and Environmental Health Laboratory (USAFOEHL) evaluate the wastewater treatment facility at the Space Launch Complex (SLC-6), Vandenberg AFB (VAFB), California. The facility's package sewage treatment plant was not meeting the discharge limits set by Discharge Order 83-60 of the California Regional Water Quality Control Board (CRWQCB). Although to date, no Notice of Violation (NOV) has been issued. California Water Code, Chapter 4, Article 4, Section 13263, Water Discharge Requirements prohibits the discharge of any waste, including overflow from treatment systems, to the Pacific Ocean. A discharge from the percolation ponds below SLC-6 was occurring; however, the CRWQCB had granted the base permission to temporarily discharge the wastewater to a spray irrigation field. The survey was conducted at VAFB from 13 May to 6 June 1986 by the following members of the USAFOEHL Consultant Services Division, Environmental Quality Branch: Major Robert D. Binovi, 1Lt Mary Daly, 1Lt Francis E. Slavich, MSgt Horace C. Burbage, Sgt Tammy Johnson, AICs Roberto Rolon and Pete Davis.

The objectives of the survey were to evaluate the: (1) influent and effluent sewage quality; (2) treatment plant flow rates; (3) lift station sewage quality; (4) percolation pond water quality; and (5) percolation pond discharge flow rate. Recommendations determining the best type of wastewater treatment to ensure compliance with discharge requirements and re-use options for the treated water were requested.

II. BACKGROUND

A. Introduction

VAFB is located in Santa Barbara County approximately 55 miles northwest of Santa Barbara. The base covers an isolated coastal area of 98,400 acres bounded by the Pacific Ocean. The effective population at the SLC-6 site was approximately 1,161 with 921, 159 and 81 people for the first, second and third shifts, respectively at the time of the survey.

The climate of VAFB is typical of the mid-California Coast with year round mild temperatures. The mean temperature range is 52-61 degrees F and receives 13.31 inches of rain each year. During the survey, only a trace of precipitation was observed (less than one hundredth of an inch).

B. Facility Description

1. Treatment Plant - General

SLC-6 was originally built to support the Air Force Manned Orbiting Laboratory (MOL) launches and was expanded to accommodate launching of the Space Shuttle. The sewage treatment package plant was designed for the MOL launches, but never expanded for the Space Shuttle, although three lift stations servicing new Shuttle Support facilities have been connected to the sewer system. The package plant was manufactured by Can Tex Industries, Mineral Springs, Texas. See Figure 1 for a photograph of the plant.

Secondary wastewater treatment is provided by this package plant consisting of a single extended aeration-clarifier unit, with discharge into three percolation/evaporation ponds. Two ponds were constructed in parallel in 1983. A third pond was added in 1985 when it became apparent the twin ponds were unable to dispose of the increased volume of water caused by contractor operations at the SLC-6. Figures 2 and 3 show the ponds.

The wastewater enters the plant through a diversion box, where flow can be diverted to completely bypass the plant. Normally, during high flow conditions, the wastewater flow passes either through a bar screen or the comminutor and into the aeration basin. From the aeration basin, flow proceeds into a clarifier where sludge separation takes place. Water passes over the weirs of the clarifier into launderers, then through a series of manholes and into the percolation ponds. Settleable sludge falls to the bottom of the clarifier's hoppers, suspended sludge is returned to the aeration basin. There is no provision for sludge wastage. Sludge must be pumped from the clarifier.

2. Treatment Plant Unit Operations

Aeration Tank - The aeration tank has a surface area of 475 square feet (ft^2) and volume of 4700 cubic feet (ft^3) or 35,000 gallons. A two and one-half inch air line carries air from the 126 ft^3 per minute blower, through 12 diffusers. Sludge from the bottom of the settling tank is air lifted at the rate of 57 gallons per minute (gpm) and returned to the aeration tank to maintain high concentrations of mixed liquor. A spray system provides foam control in the aeration basin. The aeration basin is shown in Figure 4.

Settling Tank - Mixed liquor passes from the aeration tank through a 6 inch by 12 inch inlet port to the settling tank. The settling tank has a volume of 700 ft^3 or 5200 gallons and has a 58 ft^2 surface area. The effluent flows over the weir, and then out of the plant. From the clarifier, sludge (57 gpm) and scum (43 gpm) is returned to the aeration tank. There is no provision for routine sludge wastage.

Percolation/Evaporation Ponds - The twin 67,000 ft^3 (500,000 gallon) percolation ponds are connected by an open pipe and by a valved pipe. The valved pipe was designed so that one pond could be cleaned while the other was in operation. The open pipe was added to prevent overflow in one pond (not less than 2 ft of freeboard as per regulations). Since both ponds had less than 2 ft freeboard the two ponds were hydraulically connected. It is not known the sequence by which the ponds were receiving flow since no regular maintenance of the ponds appears to take place. A third pond had been constructed which receives water from the other ponds through a pipe. This pond was full though receiving no additional water, as the fill valve was closed. Either this pond was being recharged from the underlying aquifer, or actual soil permeability was considerably less than design.

3. Sewer System

Both gravity and force mains convey the sewage from the various buildings serviced by the sewage treatment plant. Three lift stations deliver

sewage from below grade to the gravity portion of the system. Lift Station 1 (LS1), referred to in this report as the Road Lift Station, pumps sewage from a wet well receiving gravity flow from V-33 External Tank Facility and the discharge from Lift Station 2 (LS2). LS1 is shown in Figure 5. LS2 services the V-31 Solid Rocket Facility. Lift Station 3 (LS3) pumps sewage from the Launch Mount to the gravity portion of the sewer system servicing the rest of the complex. LS3 is shown in Figure 6. The pumps at LS1, LS2, and LS3 are sized at 175 gpm @ 75 foot head, 125 gpm @ 40 foot head, and 25 gpm @ 17 foot head, respectively.

C. Waste Discharge Requirements

The California Regional Water Quality Control Board, Central Coast Region, No. 83-60, 14 October 83. The order:

1. Prohibits discharge of any wastes, including overflow, or bypass to the Pacific Ocean through adjacent drainageways.
2. Limits the maximum discharge to 35,000 gpd (the design capacity).
3. Requires effluent discharged to land areas shall not have a pH less than 6.5 or greater than 8.4.
4. Requires freeboard to exceed two feet in all disposal ponds and sewage lagoons.
5. Requires a minimum ten foot separation be maintained at all times between the bottom of disposal ponds and groundwater and between the bottom of subsurface leachfields and groundwater.
6. Limits the discharge not to cause nitrate concentrations in the groundwater downgradient of the disposal area to exceed 10 mg/L (as N).
7. Prohibits the discharge from causing a significant increase of mineral constituent concentrations in underlying groundwater.
8. Prohibits under the July 82 Standard Provisions:
 - a. Introduction of incompatible wastes
 - b. Discharge of toxic wastes:
 - PCB
 - Pesticides
 - Toxic Metals
 - Cyanides
 - Halogenated Organics
 - Nonhalogenated volatile organics

Under the Monitoring and Reporting Program No. 83-60, base personnel are required to sample settleable solids monthly, total suspended solids, BOD-5, pH, and total dissolved solids semiannually, and estimate average daily flow monthly.

III. PROCEDURES

A. Flow

Influent flows were monitored continuously using a Manning UF-1100 ultrasonic flowmeter at two sites: the plant influent and the pond outflow. For the influent, duplicate measurements were taken at the grit chamber using a Palmer Bowlus flume for 6 inch diameter pipes, and the outflow pipe prior to the comminutor measured in the open channel. This is shown in Figure 7. The grit chamber flow measuring device was calibrated at 8 inches maximum liquid level. The open flow channel was calibrated at 7.75 inches maximum depth. Scum and sludge return flow rates were determined by timing the filling of a 5 gallon bucket. One flowmeter and an 8 inch diameter Palmer Bowlus flume were set at the outflow of the second percolation pond. This setup is shown in Figure 8. The flowmeter was calibrated at 7.5 inch maximum liquid level. Flow data was collected for two weeks, 19 May through 1 Jun 86.

B. Sampling

1. Sampling Site Numbers and Locations. A list of sampling site numbers and locations where the samples were taken is shown in Table 1. The sites are located as shown in Figure 9.

TABLE 1
SAMPLE SITE LOCATIONS

<u>No.</u>	<u>Sampling Site Locations</u>
1	plant influent
2	plant effluent
3	aeration tank
4	settling tank
5	sludge return line
6	scum return line
7	pond effluent
8	LS2, building V31 lift station
9	LS1, road lift station
10	LS3, launch mount lift station

2. Sampling Frequency

Daily collection of 24 hour composite samples was accomplished at Stations 1-3 for 6 days and for two days at Stations 4-6. Equipment used for this purpose was the ISCO Automatic Wastewater Composite samplers, Models 2100, 1580, and 2700. Also, daily grab samples were collected to monitor plant operation at the scum, sludge recycle, clarifier, and aeration tank (composite of eight points around the tank) and for the volatile samples. Samples were analyzed for the parameters listed in Table 2.

TABLE 2
SAMPLE PRESERVATION AND ANALYTICAL METHODS

Analysis	Preservation	Method	Where	Who
BOD-5	none	A405.1	On-Site	USAFOEHL
COD	H ₂ SO ₄ , 4°C	HACH MOD. A410.4	On-Site	USAFOEHL
Dissolved Oxygen	none	E360.1	On-Site	USAFOEHL
pH	none	A423	On-Site	USAFOEHL
Temperature	none	E170.1	On-Site	USAFOEHL
Phenols	H ₂ SO ₄	E420.	Off-Site	EAL*
ICP Metals As, Ba, Cd, Ca, Cr, Fe, Pb, Mg, Mn, Ni, Se, Zn	HNO ₃	E200.7	Off-Site	EAL
Mercury	HNO ₃	E245.1	Off-Site	EAL
Purgeable Organics	HCL	E624	Off-Site	EAL
Acid/Base/Neutral Extractables	4°C	E625	Off-Site	EAL
Nitrate-nitrite	H ₂ SO ₄	E353	Off-Site	EAL
TOC	H ₂ SO ₄	E415.2	Off-Site	EAL
TOX		E450.1	Off-Site	EAL
Sulfates	4°C	E375	Off-Site	EAL
Chlorides	4°C	E325	Off-Site	EAL
Oils and Grease	H ₂ SO ₄	E413	Off-Site	EAL
Kjeldahl Nitrogen	H ₂ SO ₄	E305.	Off-Site	EAL

Notes: A = APHA, "Standard Methods For the Examination of Water and Wastewater", 16th Ed.

E = USEPA, "Methods For Chemical Analysis of Water and Wastes"

* EAL = EAL Laboratories, Richmond CA.

C. Determination of Percolation Pond Sludge Depth

The total volume and sludge volume of each percolation pond were determined by measuring the sludge and water depth at 24 points. Both ponds were divided into a grid consisting of 24 blocks; and a pair of measurements was taken from the approximate center point of each block. The depth of water and sludge was determined with a "Sludge Judge". The average sludge and water depth was calculated for each pond and then the respective total and sludge volumes were determined.

USAFOEHL personnel performed BOD-5, total suspended solids (TSS), total dissolved solids, total and fecal coliform, pH, temperature, dissolved oxygen, COD, settleable solids, and sludge volume index on-site. Other chemical analyses were performed by contract at EAL Corporation, Richmond CA including: oils and grease, nutrients (nitrite, nitrate, and total Kjeldahl nitrogen), phenols, anions and cations, metals, priority pollutant screen, TOC and TOX. Unit processes and operations were evaluated mainly by these parameters. All analyses were performed in accordance with Standard Methods for the Examination of Water and Wastewater, 16th Ed., 1984 and U.S. EPA approved analytical methods. See Table 2 for more details on analysis.

IV. RESULTS AND DISCUSSIONS

A. Sewage Treatment Plant

1. Flow Measurements: The flow data from 19 May to 1 June are shown in Table 3. Flowmeters 1 and 2 were located at the plant influent and meter 3 at the percolation pond discharge point. Flowmeters 1 and 3 measured flow rates through 6" and 8" Palmer Bowlus flumes, respectively; while flowmeter 2 measured flow in the open channel utilizing the Manning Equation. It can be seen from Table 3 that the results from flowmeters 1 and 2 for the period of 19-24 May do not correlate. The error occurred apparently because flowmeter 2 was calibrated incorrectly with standing water in the channel. After the calibration procedures were corrected, the agreement between the results was quite good. The average flow in gal/day for the 14 day period was 65,644 for flowmeter 1. Discounting the initial 6 day period, the average flow recorded for flowmeter 2 was 63,228. The design capacity for the wastewater treatment plant is 35,000 gal/day; thus, the plant was receiving greater than 1.5 times the design capacity flow on a daily basis during the survey period.

TABLE 3

PLANT AND PERCOLATION POND FLOW

DATE	INFLUENT (gal/day)		POND EFFLUENT gal/day	EVAPO/TRANSPO/ PERCO (gal/day)
	Meter 1	Meter 2		
Sun 18 May 86	55,760	NS	NS	NS
Mon 19 May 86	90,094	*172,743	24,480	65,614
Tues 20 May 86	92,880	*293,209	27,370	65,510
Wed 21 May 86	61,280	246,661	7,200	54,080
Thur 22 May 86	64,050	101,464	7,200	56,850
Fri 23 May 86	70,980	167,384	11,520	59,460
Sat 24 May 86	47,612	136,363	7,200	40,412
Sun 25 May 86	55,530	52,348	7,200	48,330
Mon 26 May 86	58,200	56,226	10,080	48,120
Tues 27 May 86	61,560	65,920	10,080	50,480
Wed 28 May 86	62,790	78,845	8,640	54,150
Thur 29 May 86	62,805	65,920	10,080	52,710
Fri 30 May 86	76,080	74,414	10,080	66,000
Sat 31 May 86	54,408	60,103	10,080	44,328

NS = Not Surveyed

* Probably erroneous due to incorrect calibration

2. Organic Loading: The organic loading rate to the plant, (kg/kg day), calculated by dividing the average BOD-5 removal (16 kg/day) by the average MLSS (1384 mg/l) times the tank volume (133,000 liters) was 0.092. 0.10 kg BOD5/kg MLSS day is generally considered to be the recommended upper limit of organic loading for the extended activated sludge process (1).

3. Clarifier: The overflow rate for the average flow observed during the survey was 1170 gpd/ft². This is over the recommended 800 gpd/ft² loading Criteria. Peak daily flow resulted in an overflow rate of 1660 gpd/ft².

4. Settling Characteristics: The settling characteristics of the sewage treatment plant aeration basin were inferred from the results of the Sludge Volume Index Test shown in Table 4. Good settling characteristics are indicated if the SDI parameter is greater than one ($SDI = SVI/100$). All of the results satisfied this criterion except for the sample taken on 23 May 86. In addition, all SDI values are less than 150. Values above this cutoff value indicate sludge bulking is probable.

TABLE 4

AERATION BASIN DISSOLVED OXYGEN AND MLSS SETTLING CHARACTERISTICS

Date	30 min sett. ml/l	TSS mg/l	DO mg/l	SVI	SDI
17 May, Sat	200	1393	4.5	144	1.44
18 May, Sun	220	1496	3.9	147	1.47
19 May, Mon	180	1363	0.6	132	1.32
20 May, Tue	180	1557	0.6	115	1.15
21 May, Wed	170	1386	0.4	123	1.23
22 May, Thu	170	1295	0.5	131	1.31
23 May, Fri	120	1375	0.6	87	0.87
24 May, Sat	NS	NS	4.5	NS	NS
27 May, Tue	160	1213	0.6	132	1.32
28 May, Wed	NS	NS	0.8	NS	NS

NS = Not Sampled

5. Biochemical Oxygen Demand (BOD): The BOD results for the survey are shown in Table 5. The influent results for the period of 27-31 May ranged from 48 to 109 mg/l, with an average of 87.7 mg/l. The effluent values ranged from 4.82 to 49 mg/l, with an average of 18.23 mg/l for an average removal of 79.2%.

Glutamic acid check samples for each day were within the acceptable range stated by "Standard Methods for the Examination of Water and Wastewater".

6. Chemical Oxygen Demand (COD): Rejecting the data for 17 May as probably in error, the plant removed an average of 69% of the COD, while the percolation ponds removed an additional 25% for an average overall 94% removal.

TABLE 5

TOTAL SUSPENDED SOLIDS, TOTAL DISSOLVED SOLIDS, COD AND BOD

Date	No.	Location	BOD(mg/l)	COD(mg/l)	TSS(mg/l)	TDS(mg/l)
17 May Sat	1	STP Influent	NR	68	NR	460
	2	STP Effluent	NR	30	NR	NR
	7	Pond Effluent	NR	50	NR	476
18 Sun	1	STP Influent	NR	240	176	325
	2	STP Effluent	NR	97	69	408
	7	Pond Effluent	NR	15	NR	244
19 Mon	1	STP Influent	NR	375	564	44
	2	STP Effluent	NR	200	117	472
	7	Pond Effluent	NR	25	9	296
	8	No. 2 LS, Bldg. V31	NR	890	242	944
	9	No. 1 Road LS	NR	250	125	848
	10	No. 3 Launch Mt. LS	NR	200	101	488
20 Tues	1	STP Influent	NR	440	646	776
	2	STP Effluent	150	115	NR	656
	7	Pond Effluent	10	10	NR	732
	8	No. 1 LS	1300	380	NR	980
	10	No. 3 LS	148	85	NR	668
21 Wed	1	STP Influent	400	218	NR	868
	2	STP Effluent	67	40	NR	170
	7	Pond Effluent	40	4	NR	718
	9	No. 1 Road LS	NR	NR	NR	876
23 Thurs	1	STP Influent	540	430	NR	3278
	2	STP Effluent	127	73	NR	122
	7	Pond Effluent	30	NR	NR	596
27 Tue	1	STP Influent	98	550	458	336
	2	STP Effluent	85	51	NR	676
	7	Pond Effluent	2.7	37	18	196
28 Wed	1	STP Influent	109	NS	NS	NS
	2	STP Effluent	49	NS	NS	NS
	7	Pond Effluent	3.5	NS	NS	NS
	8	No. 2 LS	779	NS	NS	NS
	10	No. 3 LS	55	NS	NS	NS
29 Thurs	1	STP Influent	48	NS	NS	NS
	2	STP Effluent	4.8	NS	NS	NS
	7	Pond Effluent	2.9	NS	NS	NS
	8	No. 2 LS	380	NS	NS	NS

Date	No.	Location	BOD(mg/l)	COD(mg/l)	TSS(mg/l)	TDS(mg/l)
30	1	STP Influent	80	NS	NS	NS
Fri	2	STP Effluent	12.7	NS	NS	NS
31	1	STP Influent	103.2	NS	NS	NS
Sat	2	STP Effluent	6.4	NS	NS	NS
	7	Pond Influent	3.0	NS	NS	NS

NR = no result from sample due to lab difficulties

NS = no sample was taken

7. Nonfilterable Residue (Total Suspended Solids): The suspended solids results for the survey are shown in Table 5. Influent concentrations for Total Suspended Solids (TSS) ranged from 176 to 646 mg/l, with a weekly average of 415 mg/l. The effluent results ranged from 40 to 117 mg/l, with a weekly average of 77.5 mg/l. The average weekly percent reduction from influent to effluent was 81%.

TSS concentrations for the aeration basin and return sludge discharge are quite low. Mixed Liquor Suspended Solids (MLSS) concentrations for the aeration basin ranged from 1213 to 1557 mg/l, with a weekly average of 1385 mg/l.

8. Filterable Residue (Total Dissolved Solids): Results of TDS sampling are shown in Table 5. Average concentrations from the treatment plant influent and effluent are 869 and 417 mg/l, respectively.

9. Depth to Sludge Blanket: The depth to the sludge blanket from the top of the clarifier weir is shown in Table 6.

TABLE 6

DEPTH TO CLARIFIER SLUDGE BLANKET

DATE	FLOW (gpd)	No. OF READINGS	AVG DEPTH TO BLANKET(in)
19 May, Mon	90,094	1	4
20 May, Tue	92,880	3	3.5
21 May, Wed	61,280	1	13
22 May, Thur	64,050	1	14
23 May, Fri	70,980	1	0.5
24 May, Sat	47,612	1	21
27 May, Tue	61,560	1	0
28 May, Wed	62,790	1	15

B. Percolation Ponds

1. Flow: The average discharge from the percolation ponds for the survey period was 11,314 gal/day. This value is approximately 17% of the average daily wastewater treatment plant discharge; consequently, it appears that roughly 80% of the treatment plant discharge is lost through evaporation and percolation from the ponds. The flow results are included in Table 3.

The ponds were approximately 100 ft X 150 ft each, or approximately 15,000 ft². The northern pond's volume was measured at 66,200 ft³ (495,000 gal) and the middle pond's volume was 67,500 ft³ (504,800 gal). The measured sludge volume in the northern pond was 12,300 ft³ or 18.5% of the volume, the sludge in the middle pond occupied 14,400 ft³ or 21.3% of the volume. The sludge sampled from the bottom consisted of an average 97% water.

Using the evaporation rate of May, in the Kennedy/Jenks Design Basis (2) of 6.91 in/month for May, the infiltration rate was calculated to be 0.22 ft/day.

2. BOD-5: The BOD-5 of the percolation pond discharge point averaged 3.0 mg/l or 0.13 kg/day. The average BOD-5 removal for the total system was 96.5%.

3. Total Suspended Solids: The percolation ponds received an average TSS concentration of 77.5 mg/l, an average of 19.3 kg/day deposited in the ponds. The pond discharge TSS averaged 10 mg/l, an average of 0.4 kg/day.

4. Total Dissolved Solids: The average TDS concentration in the pond effluent was 465 mg/l.

C. Wastewater Characterization

1. BOD-5 - The results for the Building V31 lift station (779 mg/l) are indicative of nondomestic, i.e., industrial wastewater. This is especially true if these values are consistent with the low findings previously discussed. BOD values obtained at the Launch Pad Manhole are in the range of the treatment plant influent results; indicating wastewater of domestic origin.

2. COD - LS 2 (building V31) sewage had a COD of 1300 and 890 mg/l, while LS 1 had a COD of 250 and 550 mg/l, and LS 3 had a COD of 200 and 148 mg/l. The effluent from V-31 appears to be biodegradable, not refractory, as the BOD/COD ratio is greater than 0.5.

3. Volatile and Semi-Volatile Organic Compounds - The volatile organics sampling results are shown in Table 7. Methylene chloride and acetone were found at the pond discharge point. Acetone should not be a concern since it is not a priority pollutant, and is highly biodegradable. The discharge of methylene chloride is prohibited by State regulations; however, the concentration found here was quite low. Several phthalates were found at fiberglass fabrication processes or plastic pipe installation, and

probably originated at building V31. They were not detected in either the sewage treatment plant or pond effluents, however. Relatively low concentrations of 4-methylphenol were found at the STP influent and the Road Lift station.

TABLE 7

DETECTABLE AMOUNTS OF PURGEABLE ORGANICS, ACID EXTRACTABLES, AND BASE NEUTRAL EXTRACTABLES AT VANDENBERG AFB

Site	Parameter	Concentration (ug/l)
1 STP Influent	Acetone	77.0, 407.0
	4-methyl phenol	56.0
2 STP Effluent	Acetone	18.0
	Methylene Chloride	5.0
3 Pond Effluent	Acetone	39.0, 38.0
	Methylene Chloride	6.0
8 V31 Lift Station	bis(2-ethylhexyl)phthalate	1300.0
	Benzyl butyl phthalate	970.0
	di-n-butyl phthalate	330.0
9 Road Lift Station	Benzyl butyl phthalate	52.0
	4-methyl phenol	89.0
10 Launch Pad Manhole	Acetone	183.0
	Bromoform	7.0

4. Toxic Metals - The sampling results for toxic metals are shown in Table 8. Selenium was the only metal found in the percolation pond discharge. Detectable levels of selenium were also found at the influent to the STP; however, none was detected at the STP effluent. This could indicate that the selenium found at the pond discharge point came from natural sources. With the exception of the percolation pond effluent, zinc was detected at every site at relatively high concentrations. The zinc probably originated from painting operations where zinc chromate is used as a paint primer.

TABLE 8

DETECTABLE LEVELS OF TOXIC METALS AT VANDENBERG AFB

Site	Parameter	No. Days Sampled	No. Days Detected	High µg/l	Low	Avg of Detected Values
1 STP Influent	Arsenic(As)	7	4	110	35	71
	Cadmium (Cd)	7	2	20	14	17
	Chromium(Cr)	7	1	66		66
	Copper(Cu)	7	6	540	140	284
	Lead(Pb)	7	4	170	46	85
	Nickel(Ni)	7	1	64		64
	Selenium(Se)	7	2	69	51	60
	Silver(Ag)	7	1	23		23
	Zinc(Zn)	7	7	1200	180	901
2 STP Effluent	Cu	7	6	120	27	61
	Zn	7	6	760	90	285
3 Pond Effluent	Se	7	1	40		40
8 Building V31	As	2	2	83	39	61
	Cd	2	1	12		12
	Cu	2	2	280	220	250
	Pb	2	2	140	35	88
	Ni	2	1	52		52
	Se	2	1	40		40
	Ag	2	1	40		40
	Zn	2	2	2800	500	1650
9 Road Lift Station	Cu	2	2	110	110	110
	Zn	2	1	850		850
10 Launch Pad Manhole	Cu	2	2	86	83	84
	Zn	2	2	190	180	185

5. Oil and Grease - The sampling results for Oil and Grease are shown in Table 9. The 7-day average for the STP influent, effluent, and percolation pond effluent were 45.8, 1.57, and 0.0 mg/l, respectively; thus, the STP is effectively removing this parameter.

6. Phenols - The sampling results for phenols are shown in Table 9. The 7-day average for the STP influent, effluent, and percolation pond effluent were 71.4, 0.0, and 0.0 µg/l, respectively. Here again the treatment system is performing adequately.

7. MBAS - Anionic surfactants used in detergents are measured using the methylene blue active substance (MBAS) determination. The 7-day average for the STP influent, effluent, and percolation pond effluent were 0.56, 0.0,

and 0.0 mg/l. Some detergent (4.85 mg/l) was seen in the V-31 lift station effluent, though not an excessive amount. Results are shown in Table 9.

TABLE 9

DETECTABLE AMOUNTS OF VARIOUS PARAMETERS FOR VANDENBERG AFB

Site	1	2	7	8	9	10
	----- (7-day avg.) -----			----- (2-day avg.) -----		
Parameter						
Oil & Grease	45.8 mg/l	1.57	0.0	67.5	18.5	13.0
TOC	157.7 mg/l	31.0	8.9	360.0	106.5	52.0
Phenols	71.4 ug/l	0.0	0.0	350.0	100.0	0.0
MBAS	0.56 mg/l	0.0	0.0	4.85	1.8	0.0
NH3 as N	25.4 mg/l	1.0	0.11	107.5	115.0	6.4
Nitrites	<0.3	<0.01	0.05	0.1	0.2	0.6
Nitrates	<0.4	15.8	3.7	<0.4	<0.4	0.5
TKN	28.3	5.0	1.0	123	110.0	33.0
Phosphorous	6.7 mg/l	2.5	1.5	23.5	10.5	3.4
Sulfate	97.4 mg/l	101.0	104.3	81.5	110.0	98.0
Alkalinity	280	129	160	630	595	270

Note: Sites 1, 2, and 3 are 7-day averages. Sites 8, 9, and 10 are 2-day averages.

V. OBSERVATIONS AND CONCLUSIONS

A. Sewage Treatment Plant

The sewage treatment plant was not meeting State of California Ordinance by exceeding the 35,000 gpd flow limit and discharging to grade from the percolation pond. The survey also revealed that hydraulic overloading was the primary cause of high suspended solids in the plant effluent, as a strong correlation ($R = 0.91$) existed between the flow and effluent suspended solids concentration. Also involved are the low levels of dissolved oxygen (DO) maintained in the aeration basin.

The plant was designed to have a 24 hour retention time in the aeration basin. The average residence time was 12.8 hours for the survey

period. Because of this, and significant MLSS loss in the clarifiers, MLSS concentrations were far lower than the 2000 mg/l recommended minimum concentration for extended aeration plants.(1)

This overloading impacted both the aeration basin and clarifier. During weekdays the dissolved oxygen concentration in the aeration basin remained at low levels, between 0.4 and 0.8 mg/l. At these levels, exocellular polymer production and a reduction in the number of eucaryotic microorganisms occurs, with resultant increase in effluent suspended solids. As reported in the literature, and seen in the results of this survey, the SVI was not effected at these concentrations since these DO concentrations are still high enough to inhibit filamentous bacterial growth.(3)

The plant was designed for a hydraulic loading of 30 gpd/capita and 930 people to support the MOL Launch Facility. The design organic loading was 0.1 pounds (0.045 kg) of BOD-5 per capita/day, setting the MLSS concentration at 3000 mg/l. The plant was processing an average of twice the hydraulic load, but if the BOD-5 tests are correct, a little more than half the design organic load. In reality, the plant should have been designed for at least double this hydraulic loading. Unfortunately, this erroneous design basis was used to design the percolation basins as well.

The clarifier's weirs were hydraulically overloaded. The depth to the sludge blanket were never sufficient for adequate suspended solids removal, see Table 6.

The aeration basin's dissolved oxygen levels were found to be low despite a seemingly adequately amount of design air (not measured) and an organic loading less than design. The cause may be the degradation of the diffusers and the inability of the diffusers to provide sufficient air-water interface area. Also, the addition of slugs of septic sewage from LS 1 may be keeping the dissolved oxygen level low.

B. Percolation Ponds: The ponds ability to dispose of the water through percolation suffered from the heavy suspended solids loading. The sludge was unevenly distributed in the ponds. Also interfering with evaporation is the heavy algal blanket growing in the ponds. The contractors had recommended these ponds be dragged to remove the algae. This evidently hadn't been done. Groundwater may also be infiltrating the ponds. Wildman and Morris(2) found perched water 13 feet below bore hole 1 at elevation 320 ft MSL (307 ft MSL). The percolation pond bottoms are at elevation 316 MSL, leaving nine feet between groundwater and pond. CRWQCB Order No. 83-60 requires a ten foot separation.

Denitrification is occurring in the ponds, probably under anaerobic conditions in the pond sediment or as a result of aquatic nitrogen fixation. The concentration of nitrate is reduced from 15.8 mg/l to 3.7 mg/l.

C. Sewer System:

The three sewer system lift stations are contributing to the decreased effectiveness of the treatment plant by causing surges in the normal

wastewater flow. Each time the lift stations are activated, flow through the treatment plant-grit chamber exceeds 100%. This surge of flow decreases the residence time in the treatment plant, causing a washout of suspended solids to pass over the clarifier weirs.

Also, the long residence times and possibly sludge accumulation in Lift Stations 1 and 2 wet wells are causing sewage to become septic. When pumped, this septic slug has detrimental effects on the aeration system's ability to maintain adequate dissolved oxygen levels in the aeration basin.

D. Reuse Options:

Options to effect a "zero discharge" from the treatment plant include water limitation, aquifer recharge through deep well injection, percolation, and irrigation.

1. Water conservation - Water conservation efforts should be concentrated toward reduction of washing equipment and vehicles which can be moved to the main base for the same function. Washing of vehicles and equipment amount to significant volumes of water which are not necessarily beneficial to the operation of extended aeration plants. It was not apparent where or whether significant quantities of washwater were entering floor drains connected to the sewer system. From the low surfactant concentrations, little washing using detergents was occurring.

2. Deep well injection - Deep well injection as a means of combating seawater intrusion is a viable option, though injected water quality cannot significantly degrade the quality of the receiving aquifer or exceed 10 mg/l nitrates. The average nitrate level in the pond effluent was 3.7 mg/l leaving this possibility open.

3. Percolation - The construction of an additional percolation pond after adequate siting and subsurface investigation is another alternative to meet the zero discharge limitation. According to Table 3, the twin additional similarly sized percolation ponds would handle the overflow.

4. Irrigation - A temporary spray field was being set up at the time of the survey. It was considered temporary, as the CRWQCB was allowing it to take place until a more permanent solution could be found. Launch complexes at Kennedy Space Center are grassed, heavily fertilized, and watered to overcome the effects the hydrogen chloride cloud has on the appearance of the complex. If the plan includes slope stabilization by establishing grasses, a need for water for irrigation would arise. Properly treated secondary effluent could fill this need. Besides establishing the irrigation network, a clear well could be constructed in the outfall line with overflow to the ponds. A pump could draw from the clear well to supply site irrigation needs. Alternately, water could be drawn from the ponds with pumps of greater hydraulic head and delivered back to the SLC-6.

VI. RECOMMENDATIONS

A. Now that the space launch operations at SLC-6 have been postponed, and hydraulic loading has been reduced, the need to expand the treatment plant to handle the amount of loading seen in June 86 is not as critical or necessary. The following recommendations should be considered regardless.

1. A flow measuring device such as Parshall Flume or Palmer Bowlus with associated meter or gauge should be installed in the influent line somewhere after or in conjunction with the diversion box. This would satisfy the requirement of CRWQCB Order No. 83-60 for flow estimation.

2. The high level shut off for lift stations 1 and 2 should be adjusted lower, so that the pumps will operate more frequently but deliver a smaller volume, eliminating the current surge conditions. Workers must be careful on entering these stations, as the sewage seems to be septic from its long residence time, and as a result, methane and hydrogen sulfide gas is probably present.

3. Along with flow measurement, increased testing should be performed to assure the proper operation of the plant. As a minimum, influent, mixed liquor, and effluent suspended solids should be monitored daily but at least weekly. Depth to sludge blanket observations, depth of sludge in the clarifiers, aeration basin dissolved oxygen, alkalinity, and pH should also be monitored.

4. The percolation ponds should be dragged to remove the accumulated aquatic growth, then dredged to remove the accumulated treatment plant solids. The dragging should take place annually. Dredging may need to be performed once, if the effluent solids are brought under control.

5. Observation wells should be installed around the percolation pond into the first underlying aquifer to monitor if aquifer quality is being adversely affected. Water table elevations could be recorded from the wells, also, as a check on compliance with the separation criteria and to establish that pond recharge is not occurring.

B. The following recommendations are contingent on the projected use and population working at the Space Launch Complex.

1. Enlarge the aeration basin and clarifier capacities if the working population is expected to be over 550 people. If the results of this survey are considered, the basis of design would be 60-80 gal/capita day.

2. If flows will exceed about 40,000 gallons per day, consider the construction of an additional percolation pond, or a deep well injection system for percolation pond effluent.

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1. Gua, Paul H.M., et. al., "Evaluation of Extended Aeration Activated Sludge Package Plants, Journal WPCF, Vol. 53, Number 1, January 1981.
2. Wildman & Morris, Inc., Percolation/Evaporation Pond STS at Vandenberg Air Force Base CA, Basis for Design Calculations Soils Report, November 1983.
3. Starkey, J.E. and P.R. Karr, "Effect of Low Dissolved Oxygen Concentration on Effluent Turbidity", Journal WPCF, Volume 56. No. 7, July 1984.

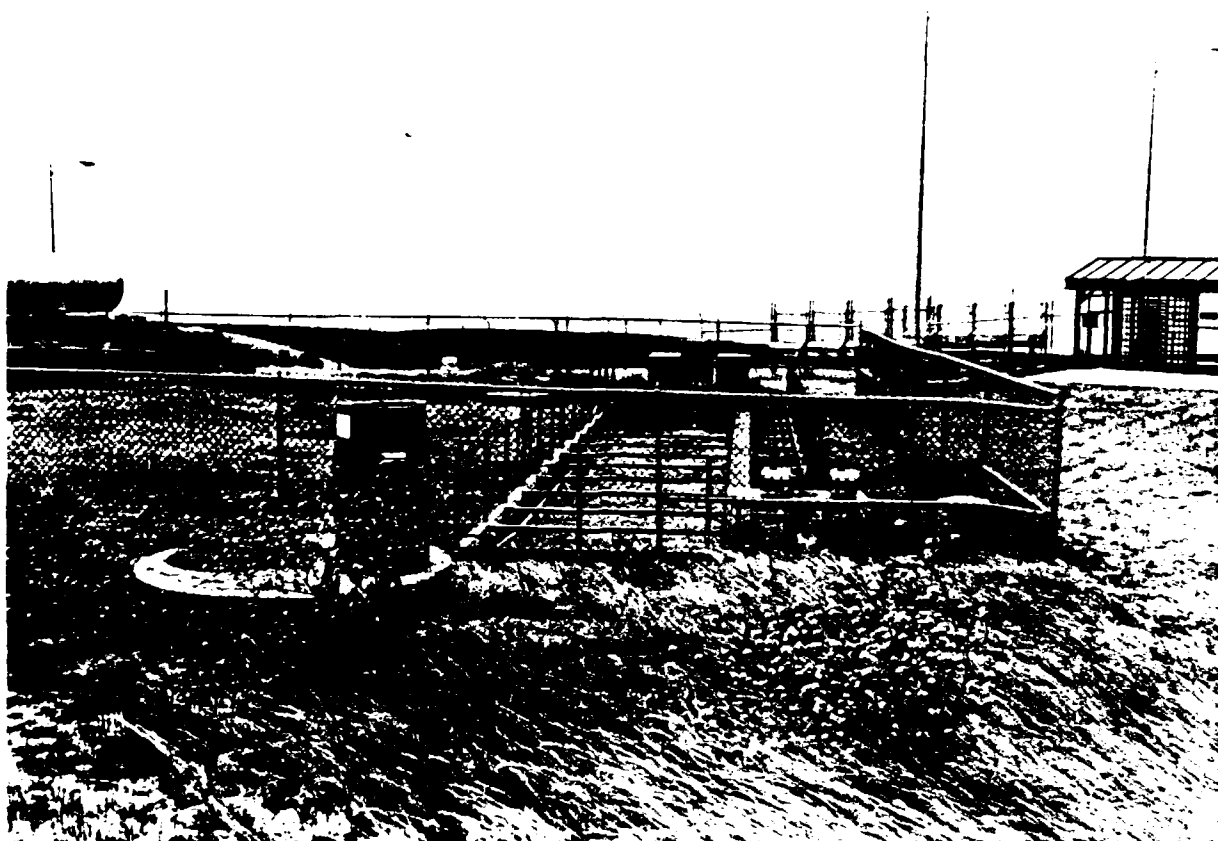


Figure 1, Gen Tex Extended Aeration Plant
SLC-6, Vandenberg AFB



Figure 2: Percolation Ponds Constructed in 1983



Figure 3: Percolation Pond Built in 1985

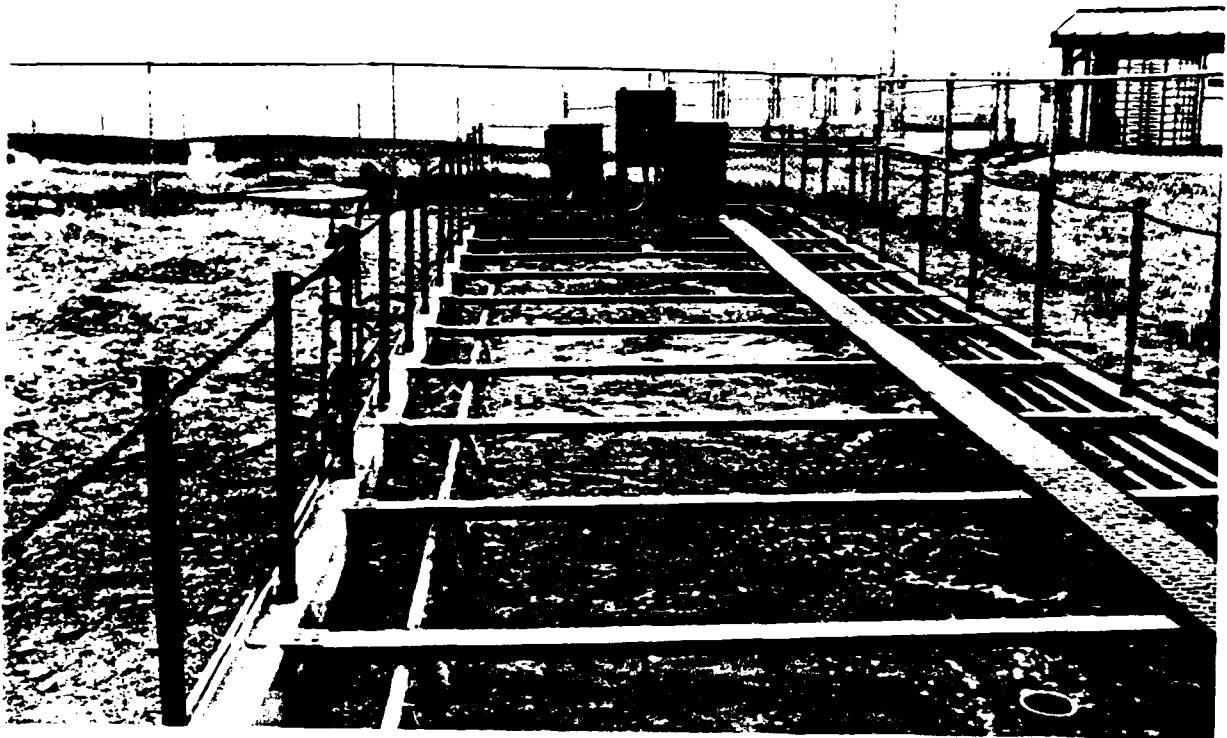


Figure 4: Aeration Basin & Foam Control

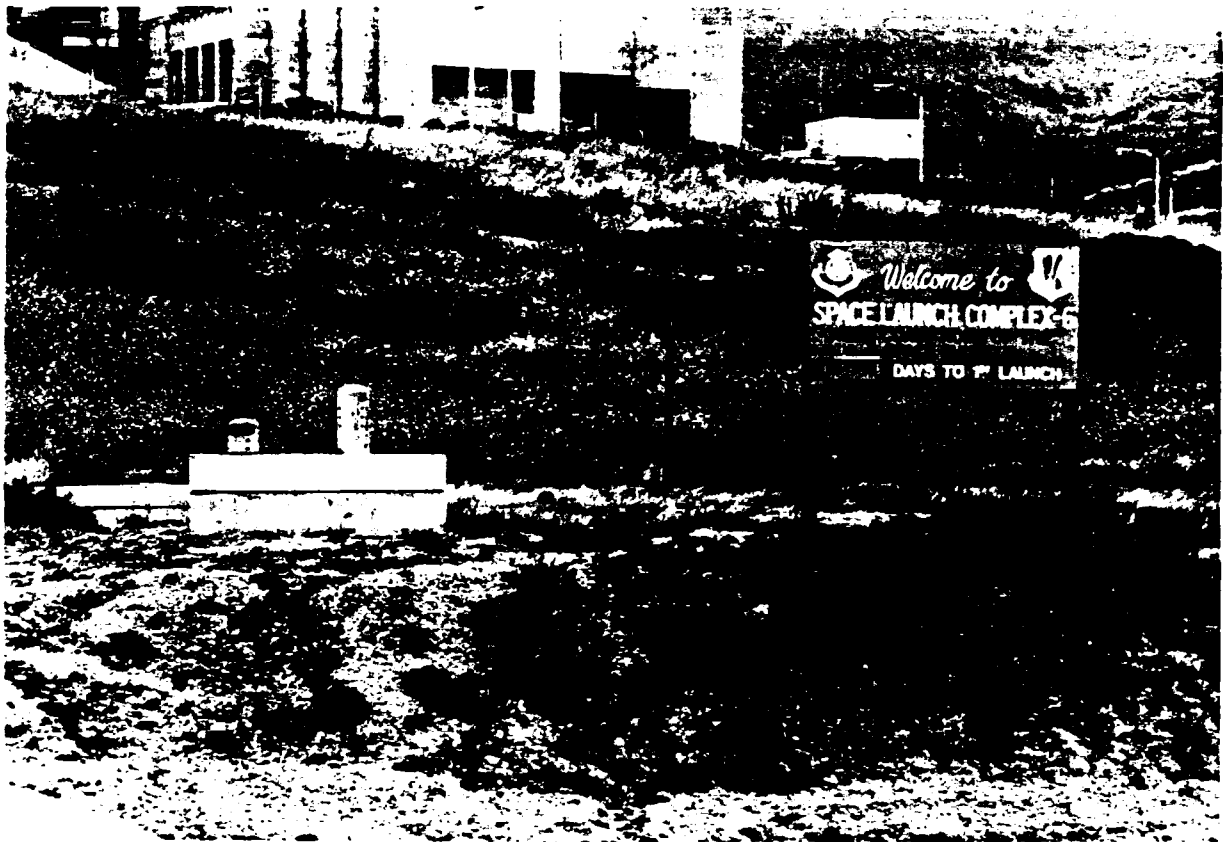


Figure 5: Lift Station 1

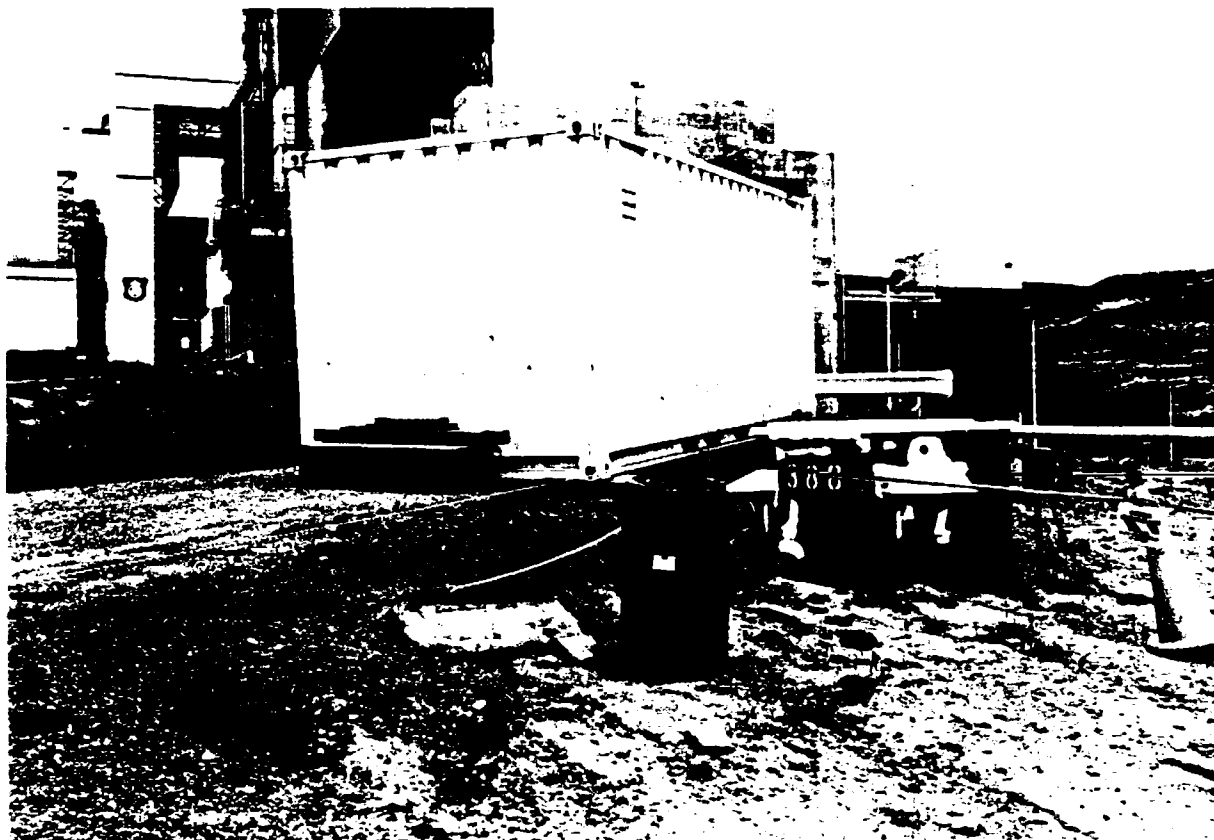


Figure 6: Lift Station 3



Figure 7: Plant Influent Flow Measurement

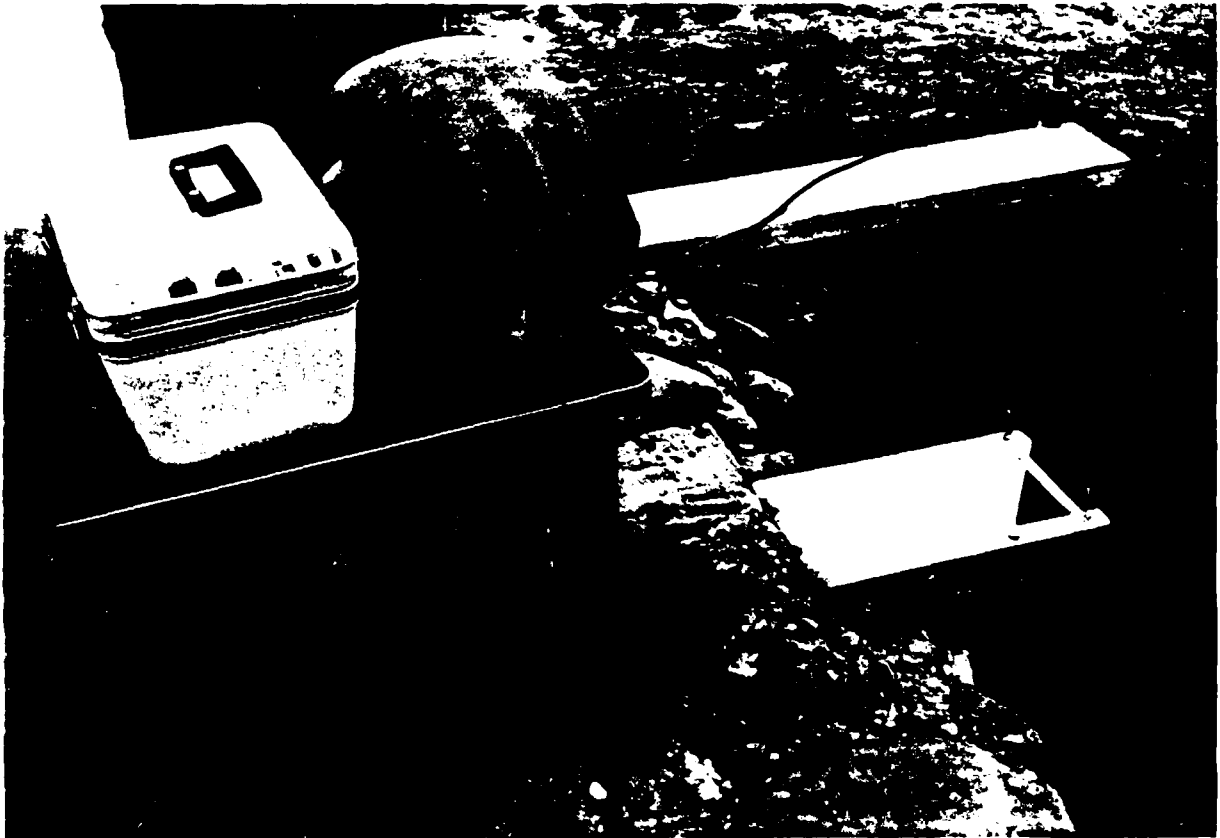


Figure 6: Percolation Pond Flow Measurement

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